1-1-1969

Lunar Module (LM) - Orbit Rate Drive Electronics (ORDEAL) for Apollo and LM along with malfunction procedures

National Aeronatics and Space Administration (NASA)

ORBIT RATE DRIVE ELECTRONICS FOR APOLLO AND LM

ORDEAL Description

The ORDEAL is an electromechanical device containing a pair of resolvers, one for each FDAI, which are driven by a stepper motor at the orbital rate selected by the Altitude Set dial.

The resolvers may be switched directly into the pitch total attitude channels of the FDAI's providing a display of spacecraft attitude with respect to a local horizontal reference frame. These resolvers transform the pitch angle in accordance with their shaft position which is driven by a digital rate servo. The desired shaft rate is obtained by controlling the pulse rate that is applied to a stepper motor. This pulse rate is derived from the spacecraft's 400 $\pm\frac{1}{2}$ Hertz frequency and counted down as required by digital logic.

Since the transformation is made in the pitch channel only, it is imperative that the inertial reference be aligned with the +Y axis of the reference along $(\overline{V} \times \overline{R})$ where $\overline{V}$ is the velocity vector and $\overline{R}$ is the position vector from center of the earth.

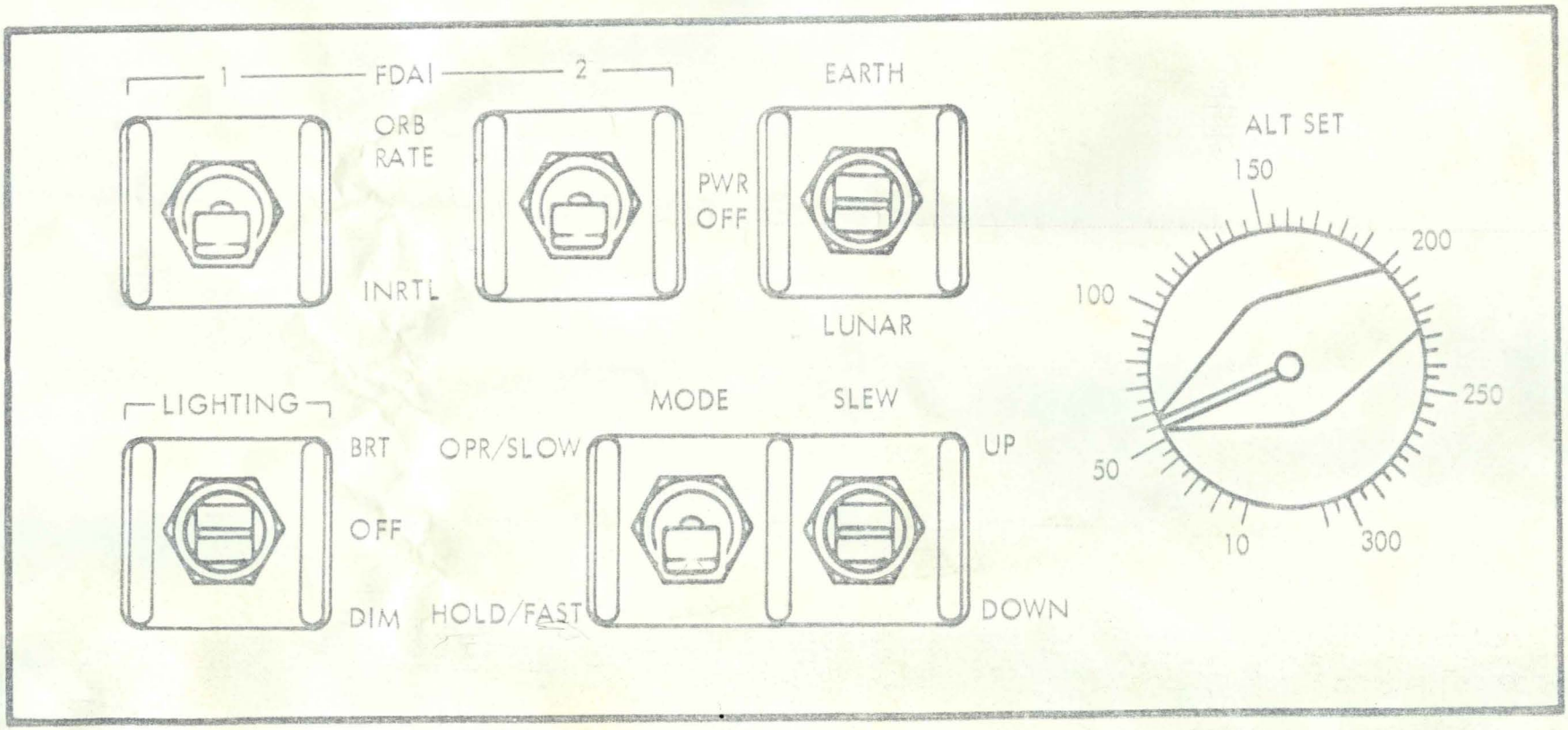
Operation

After obtaining spacecraft attitude with respect to local horizontal from the onboard computer, the selected FDAI is slewed to this angle. The ORDEAL will then torque its resolvers at the orbital rate of a circular orbit specified by the Altitude Set dial.

ORDEAL Leading Particulars

Operating power (A-C)	115 ±2.5 vrms, single phase, 400 cps
Power consumption (A-C)	4 watts at 0.9 power factor minimum
Operating power (D-C)	28 ±3 volts
Power consumption (D-C)	4 watts

ORDEAL PANEL



SCS-4000A

4.10.2.8 ORDEAL Initialization

The purpose of this procedure is to align one or both FDAI's to local vertical coordinates.

The following are required:
CMC - on (for 3A & 6A) para 4.10.1.2
ISS - on and aligned, nominal option (for 6A) para 4.10.1.2, 4.11
SCS - on (para. 4.10.2.2)
CMC ATT - IMU
SCS LOGIC BUS 3 - on (up)
.05 G Sw - OFF

The IMU and/or the SCS Attitude Reference System must be aligned with the +Y axis of the reference along ($\underline{V} \times \underline{R}$), where $\underline{V}$ is the velocity vector and $\underline{R}$ is the position vector from center of the earth.

1 Select Total Attitude Display (para. 4.9.2.5)

2 Set ORDEAL Controls (para 4.9.2.6)
FDAI 2 or 1 - ORB RATE
ORDEAL PWR sw - EARTH
MODE - HOLD/FAST

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Either or both FDAI's may be driven by ORDEAL.

3 Obtain altitude setting

a. Orbit Parameter Display Routine
Key V82 E
Record apogee and perigee and calculate average.

2,140 V82, which is an extended verb, may not be called if another extended verb is in operation.

or b. Ground Track Determination Program
Key V37E 21E
Record altitude for 10 minute intervals of the present orbit and calculate average.

or c. MSFN
If CMC is in STANDBY, obtain altitude setting from MSFN

4 ALT SET - adjust to proper altitude

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CDR

5 Damp Vehicle Rates (Drift Rate Adjust) (para 4.9.1)
para 4.10.2.4

6 Obtain θ - Pitch angle to Local Horizontal

θ is the angle between $+X_{SC}$ and local horizontal plane. Positive indicates $+X_{SC}$ above plane.

a. Rendezvous Parameter Display Routine V83E

or b. MSFN

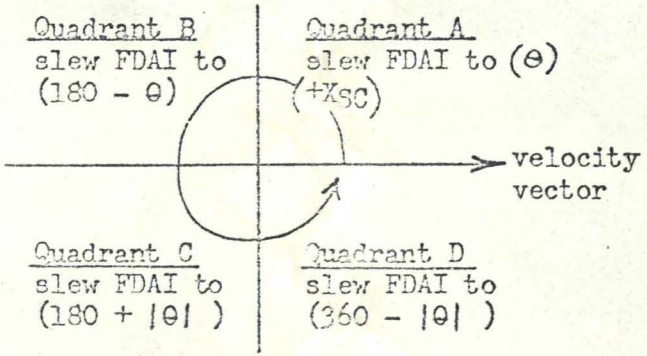
If CMC is in STANDBY, obtain θ from MSFN based on $+X_C$ pointed at the horizon.

Maneuver to point $+X_{SC}$ at the horizon (para. 4.10.2.5)

θ is dependent on present altitude.

7 Slew FDAI to angle indicated by the following relationship of the velocity vector and $+X_{SC}$ in the quadrants shown.

The CMC display of θ is from -90° to +90°.



8 MODE - OPR/SLEW

Slew/adjust FDAI precisely

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The FDAI may be more accurately adjusted using the 1° marks, if the yaw angle is 0° and the roll angle 0° or 180°. When the momentary SLEW switch is released, ORDEAL is in the operate mode.

9 Repeat Steps 6 through 8 as Required

FDAI-1 & 2 sws must be at INRTL (pwr. OFF, or not), to display pitch inertial attitude.

SYMPTON

PROCEDURE

REMARKS

FDAI fails to torque in ORB RATE

FAILS TO DRIVE
DRIVES SLOW
RUNAWAY DRIVE

1 ~~Check FDAI's~~ FDAI CHECK
- ~~FDAI PWR - BOTH~~
- ~~FDAI SELECT - 1/2~~
- ORDEAL - FDAI SW (~~BOTH~~) - INRTL
- ~~Command 3-axis maneuver~~

2 FDAI's OK ? — No → 3 Go to SCS M.F. Proc. | X | X

Yes

Switch other FDAI to ORB RATE

4 ~~ORDEAL - FDAI - (BOTH) - ORB RATE~~

Does other FDAI torque ? — No → 6 ORDEAL Failed ①

Yes → 7 ORDEAL FDAI 1 or 2 resolver Failed ②

① Assumes inertial reference for Orb Rate FDAI is aligned in plane.

① Caution - ORDEAL MNB (CB64) supplies power to SECS B

② Use other FDAI for ORB RATE

FDAI fails to slow ~~IN ORB~~ WITH ORDEAL

1 ORDEAL - MODE - OPR/SLOW

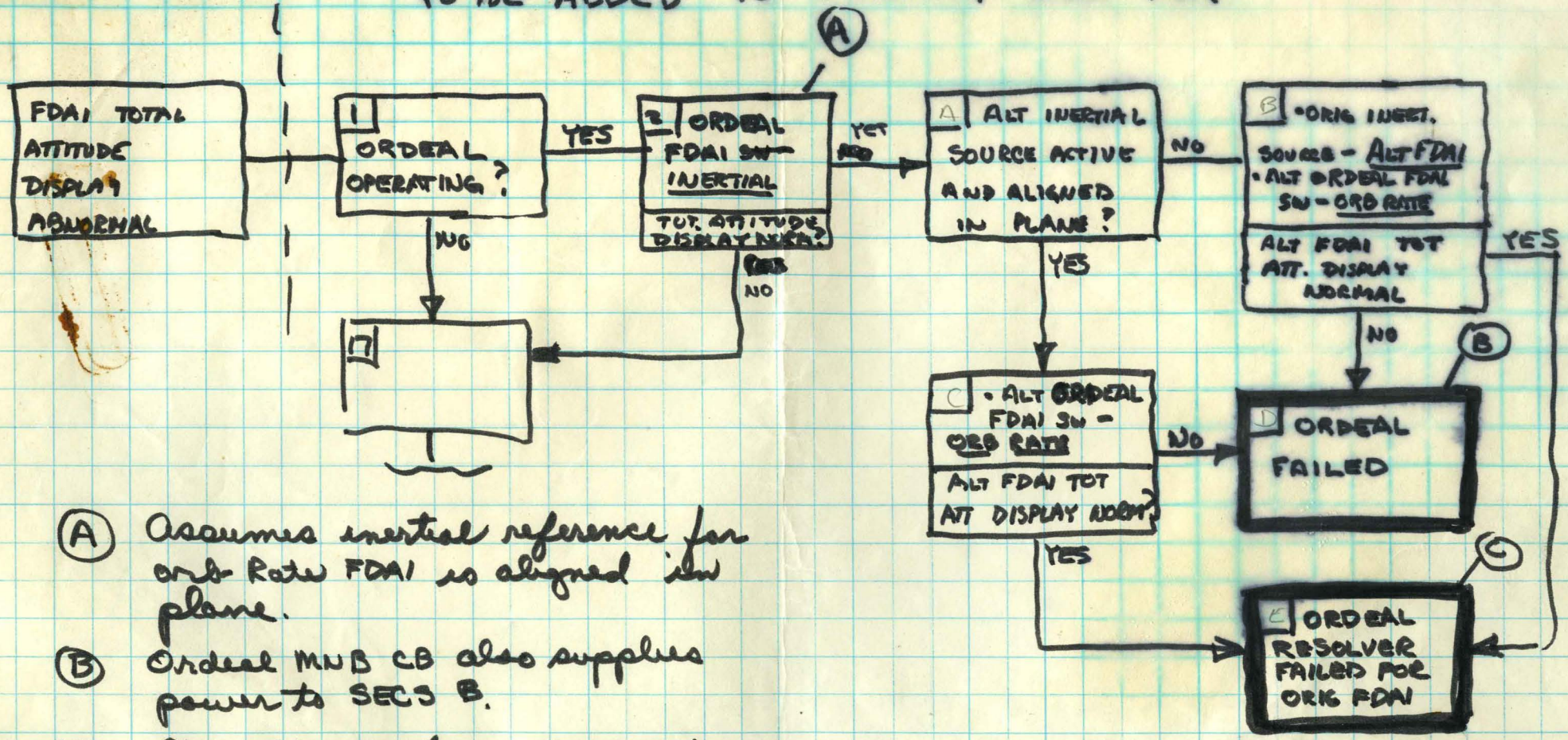
2 Does FDAI slew ? — Yes → 3 Fast slew function Failed ①

No → 4 Slew function Failed ②

① Slew FDAI at slow rate

② Assuming an inplane GDC Alignment, The FDAI pitch angle may be cal by pressing GDC ALIGN and slewing the Pitch ATT SET TW.

TO BE ADDED TO EXISTING SCS PROC

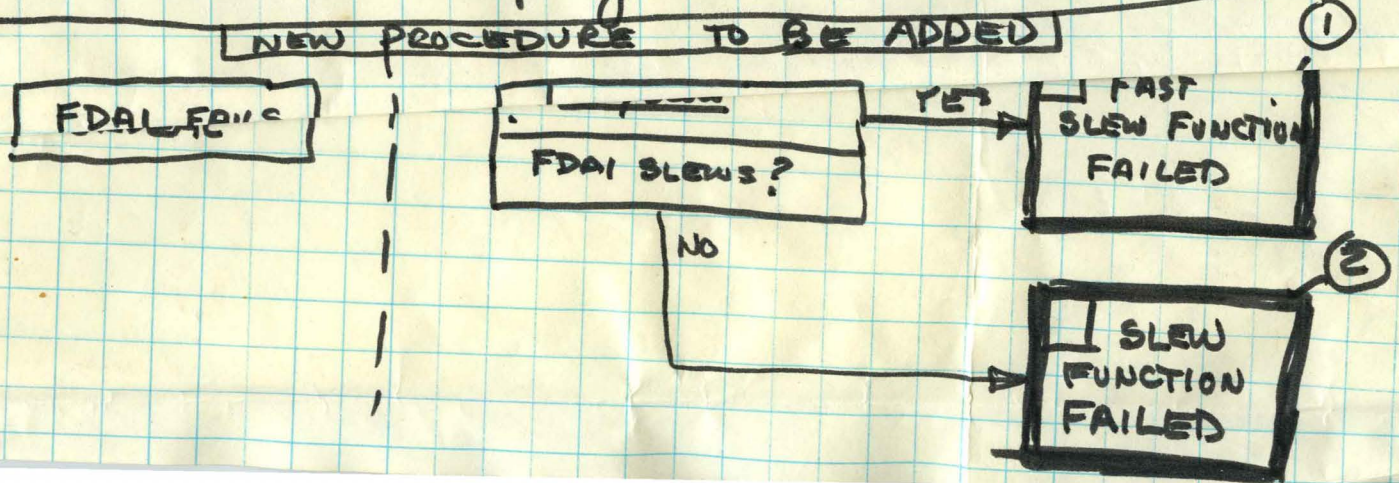


(A) Assumes inertial reference for orb Rate FDAI is aligned in plane.

(B) Ordeal MNB CB also supplies power to SECS B.

(C) Use alt FDAI for subsequent orb Rate display.

NEW PROCEDURE TO BE ADDED



(1) Slew FDAI at [illegible] rate

(2) With an in plane GDC alignment, the FDAI pitch angle may be set by preparing GDC align and allowing the pitch attitude set T/W.

MALFUNCTION PROCEDURES INDEX

GUIDANCE AND CONTROL

G&C

1. Abnormal Vehicle Dynamics during SPS Thrusting
2. FDAI Attitude Error Abnormal
3. FDAI Rate Ind. Abnormal
4. FDAI Total Attitude Display Abnormal
5. FDAI Fails to Slew with ORDEAL
6. FDAI Total Attitude does not respond to GDC Align
7. GPI/Fuel Press Ind.(s) Pegged or Zero

A. Abnormal Vehicle Dynamics During Non-SPS Thrusting:

SCS

1. RCS Failed On
2. Accel CMD Troubleshooting Routine
3. Rate CMD Troubleshooting Routine
4. Min Imp Troubleshooting Routine
5. Direct RCS Troubleshooting Routine
6. Vehicle Dynamics Oscillating & Diverging
7. Translation Troubleshooting Routine

G&N

1. RCS Failed on
2. RHC Troubleshooting Routine
3. THC Troubleshooting Routine
4. Min Imp. Controller Troubleshooting Routine
5. CMC Lite On
6. ISS Lite On
7. Temp Lite On
8. Gimbal Lock Lite On
9. Restart Lite On
10. Tracker Lite On
11. Prog Lite On
12. Alarm Codes

SSR-1 CMC Self Test
SSr-2 CMC Quad Fail
SSR-3 Fresh Start

SERVICE PROPULSION SYSTEM

1. SPS Press Lite On.
2. Premature Eng Cut-Off
2a. No SPS Eng Ignition
2b. Rough ECO Lite On
3. Engine Does Not Shut-Down
4. SPS Flange Temp Hi
5. SPS Pc Abnormal
6. SPS He Vlv tb Abnormal

7. He Tank Press Low or Decreasing
8. GN2 Press Low
9. SPS Eng Ins Vlv Ind Abnormal
10. No Propellant Temp Control
11. No Response of OXID Flow VLV tb During Flow Adjust
12. SPS Qt Qxid Unbalance Ind Erratic or Pegged
13. SPS Qty % OXID (% Fuel) Ind. Readout Abnormal

REACTION CONTROL SYSTEM

SM-RCS

1. SM RCS A(B, C, D) Lite On
1a. CM RCS Pkg. Temp Ind - Low
1b. SM RCS Pkg. Temp Ind - High
1c. SM RCS Manf Press Ind-Low
1d. SM RCS Manf Press Ind - High
2. SM RCS He Press Ind - Low or Decr.

CM RCS

3. CM RCS A(B) Lite On
3a. CM RCS Fuel/Oxid Manf Press Ind - High
3b. CMRCS Fuel/Oxid Manf Press Ind - Low
4. CM RCS He Press - Low or Decreasing
5. CM RCS Eng Temp Fails to Increase

ELECTRICAL POWER SYSTEM

CRYO

1. CRYO Press Lite - On
1a. Oz (H2) Press - High
1b. OZ (H2) Press - Low

FUEL CELLS:

1. FC 1 (2,3) Lite - on
1a. FC 1 (2,3) MOD Skin Temp - High
1b. FC 1 (2,3) Mod Skin Temp - Low
1c. FC 1 (2,3) Mod. Cond Exh Temp - High
1d. FC 1 (2,3) Mod Cond Exh Temp - Low
1e. FC 1 (2,3) pH Hl tb - bp
1f. FC 1 (2,3) Rad Temp Low
1g. FC 1 (2,3) O_2 (H_2) Flow - High
2. FC 1 (2,3) O_2 (H_2)
3. FC Reg O_2 (H_2) Out Press - High
4. cb FC 1 (2,3) PUMPS AC - open
5. FC 1 (2,3) VIT Performance Low

POWER DISTRIBUTION:

1. MN BUS A (B) Undervolt LT - On
1a. AC BUS 1 (2) Lt - ON
1b. Mn BUS A (B) Indicates 26V
1c. AC BUS 1 (2) Voltage Low
1d. AC BUS 1 (2) Voltage High
2. Inv 1 (2,3) Temp HI Lt - ON
3. FC BUS Disconnect Lt - ON
4. Suspected High Current for SC Configuration
SSR-1 FC Shutdown
SSR-2 Bus Short Isolation

TELECOMM

1. One Crewman has no Intercom Capability
2. Loss of Intercom (All Crewman)
3. One Crewman has Abnormal Hot Mike Condition
4. Loss of VHF Comm
5. Loss of S Band Voice Comm
6. Cannot Acquire Phaselock
7. MSFN Reports Loss of Ranging
8. MSFN Reports Loss of PCM

ENVIRONMENTAL CONTROL SYSTEM:

1. O2 Flow Hi lt - on
1a. O2 Flow ind - HIGH
2. O2 Flowind - LOW
3. SURGE TANK PRESS HIGH
4. SURGE TANK PRESS LOW
5. CO2 PP HI lt - on
5g. CO2 PART PRESS ind - HIGH
5d. CO2 PART PRESS ind - LOW
6. CO2 FILTER Seizure Within Canister
7. Ballooned PGA's
8. CLINGING SUIT
9. SUIT COMPRESSOR lt - on
9a. SUIT COMPR P LOW
10. CREW UNCOMFORTABLE IN SUIT LOOP
10a. Suit CKT HUMIDITY HIGH
11. CABIN PRESS HIGH OR INCREASING
12. CABIN PRESS LOW OR DECREASING
13. CREW UNCOMFORTABLE IN CABIN
13a. CABIN HUMIDITY HIGH
14. GLYCOL TEMP LOW - lt - on
14g. PRIM ECS RAD OUT TEMP LOW
15. PRIM ECS RAD OUT TEMP HIGH
16. PRIM GLY EVAP OUT TEMP HIGH
17. PRIM GLY EVAP OUT TEMP LOW
18. PRIM GLY DISCH PRESS LOW
19. PRIM GLY ACCUM QTY LOW OR DECREASING

20. PRIM GLY ACCUM QTY HIGH
21. SEC ECS RAD OUT TEMP LOW
22. SEC ECS RAD OUT TEMP HIGH
23. SEC GLY ACCUM QTY DECREASING

ENTRY MONITOR SYSTEM:

1. .05 G lt - on (TEST 1)
2. G/V Scroll assy does not slew (TEST 1)
3. .05 G lt - out (TEST 2)
4. RSI Lower lt will not come on (TEST 3)
4a. RANGE ind will not slew (TEST 3)
5. V-AXIS only or multiple displays abnormal (TEST 4)
6. RANGE ind only abnormal (TEST 4)
7. G-AXIS only abnormal (TEST 4)
8. RSI Upper lt not on (TEST 5)
8a. G-AXIS does not drive (TEST 5)
9. RANGE ind does not slew in RNG SET
9a. G-AXIS does not zero in RNG SET
10. V-AXIS does not slew in Vo SET
11. RANGE/ V ind abnormal in V TEST
12. SPS THRUST lt not on in V TEST
13. V ind does not slew in V SET
14. Abnormal thrust cutoff in SCS V
15. RANGE/ V ind fails to count after SPS firing
16. G-noted but .05 G lt not on in ENTRY
16a. RANGE ind does not decrease when .05 G noted (.05 G, CMC, or MSFN)
17. Scroll display(s) do not drive during ENTRY (G build up noted)
18. Neither RSI lts on 10 sec after .05 G lt
19. RSI Upper lt on after 2 G